

GREEN GLASSES: NEW PRESSURE CALIBRATION, NEW ASCENT MECHANISM, NEW CALCULATIONS, SAME STORY. John Longhi, Lamont-Doherty Earth Observatory, Palisades, NY 10964 (longhi@ldeo.columbia.edu)

New melting experiments that have located the trace of the Di-Wo eutectic from 0.5 to 2.5 GPa (1370°C – 1520°C) have also demonstrated pressure intensification in BaCO₃ pressure assemblies in contrast to friction-induced pressure reduction at lower temperatures. Accordingly, BaCO₃ assemblies require a correction that is both temperature and pressure dependent. Application of such a correction yields pressures for the CMAS spinel/garnet transition (SGT) and quartz-coesite transformation (QCT) in close agreement with salt-cell data [1,2,3]. The pressure correction also requires modification of melting model algorithms [4] and re-examination of the polybaric fractional fusion hypothesis for green glass magmas [5]. Also, recent development of a model for run-away dike propagation [6] raises the possibility of rapid magma transport directly from deep source regions thus making batch melting processes plausible.

Several labs now employ pressure BaCO₃ media in piston cylinder experiments. Careful calibration against the melting curve of gold has shown the need for a -0.2 to -0.4 GPa correction due to friction in piston-in experiments (Fig. 1). Recently, however, a discrepancy of ~0.8 GPa was discovered between determinations of the high-temperature (1500°C) portion of the spinel/garnet transition in BaCO₃ and CaF₂ assemblies on the one hand (~2.2 GPa) [7] versus talc/pyrex assemblies on the other (~3.0 GPa) [8]. In an effort to determine friction losses at higher temperatures the eutectic curve in the Di-Wo system was determined in both piston-in and piston-out experiments (Fig. 1). At the lower temperatures of the gold melting curve piston-in measurements lie at systematically higher pressures than piston-out measurements of the same equilibrium; whereas at the higher temperatures of the Di-Wo eutectic piston-in experiments that locate the equilibrium lie at systematically lower pressure than piston-out determinations of the equilibrium. The lower temperature experiments are consistent with frictional losses in the assemblies, whereas the higher temperature experiments are consistent with pressure intensification ("anvil" effects). A reasonable explanation is that both processes are present at low temperatures, but that friction diminishes with increasing pressure, leaving anvil effects dominant. Accordingly, corrections to true pressure in solid media assemblies must be both

pressure and temperature dependent. Application of such a correction to L-DEO determinations of the SGT and QCT yields pressures that are ~ 0.5 GPa (1560°C) and 0.1 GPa (1400°C) higher, respectively, in close agreement with determinations of these equilibria in salt cell experiments [1,2,3].

The new pressure calibration yields substantially higher pressures (0.3 to 0.7 GPa) for the experiments upon which previous calculations of polybaric fractional fusion are based [4,9]. Fig. 2 illustrates a new set of calculations of polybaric fractional fusion relevant to petrogenesis of the green glass magmas. The calculations show that source compositions with chondritic abundances of refractory elements (e.g., LPUM) produce pooled liquids that have concentrations of Al₂O₃ and CaO that are far too high for the green glasses (green circles). Source regions with very low Al₂O₃ concentrations (0.8 to 1.4 wt %) produce pooled liquids that track across the array of green glass compositions in the [Wo] projection. In the [Ol] projection (Fig. 2b) the Wo contents are too low, which implies that source regions with similar Al₂O₃ but higher CaO would produce pooled melts that do match.

Recently, Wilson and Head [6] developed a model for a propagating dike tip that holds promise of transporting magma hundreds of kilometers very rapidly. Such a process could potentially deliver batch melts from source regions 200 to 600 km deep to the surface with little or no differentiation. A relevant melting process would be polybaric equilibrium melting in which decompression provided the heat for melting. Melt segregation and dike formation would take place when the porosity limit was exceeded. Fig. 3 illustrates calculated equilibrium melting paths for the same source compositions as in Fig. 2. Results are generally similar, except that the fit to the green glass compositions is better. Although not unique the calculations are consistent with a source mineralogy that is 65% to 75 wt% olivine and the remainder orthopyroxene. The difference between the 2 sets of calculations holds promise that the nature of the melting process may be determined.

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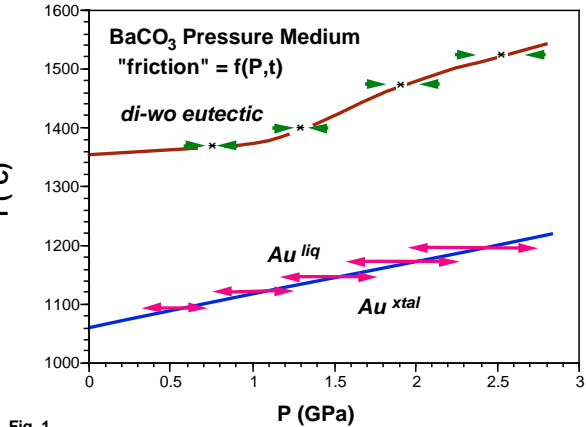


Fig. 1 Melting curves of pure gold and the Di-Wo eutectic. Experiments in graphite capsules with BaCO₃ pressure medium. Data points at tips of arrows. Right-pointing arrows indicate piston-in experiments; left-pointing arrows indicate piston-out

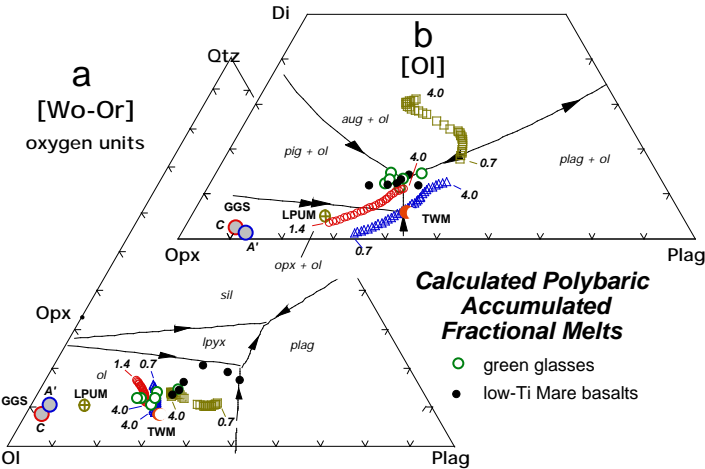


Fig 2 Polybaric fractional fusion calculations of differentiated (GGSA, GGSC) and primitive (LPUM) green glass source regions. Symbols are pooled liquid compositions; numbers are pressure in GPa. Light, solid curves are low pressures liquidus boundaries.

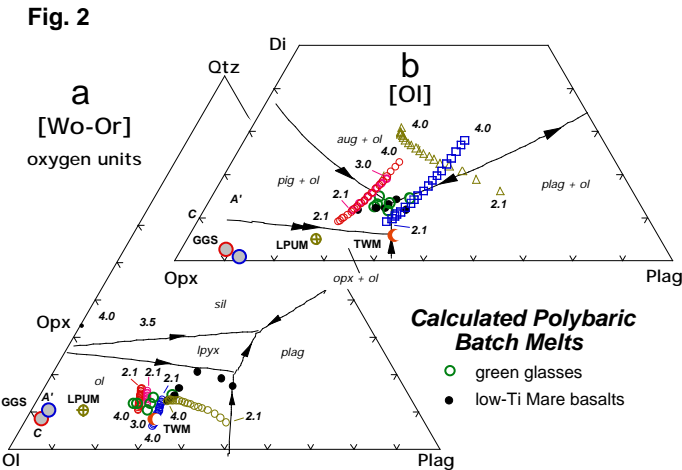


Fig 3 Polybaric equilibrium melting calculations of differentiated (GGSA, GGSC) and primitive (LPUM) green glass source regions. Symbols are batch liquid compositions; numbers are pressure in GPa.

Fig. 3